SUPPLEMENT TO INSTRUCTIONS GEI-19645-K

AUXILIARY HIGH SPEED SWEEP ASSEMBLY KIT

FOR USE WITH

HC-2J-C1, C2 CATHODE-RAY OSCILLOGRAPH

CATALOG #514211101

GENERAL ELECTRIC COMPANY
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I DESCRIPTION

The auxiliary high speed sweep generator is designed to perform the following functions in conjunction with a HC-25-C1 or C2 cathode-ray oscillograph:

A. Supply horizontal sweep voltages of lengths

0.1 microsecond

0.2 "

0.4 "

0.6 "

1.0 "

B. Supply 20 mc/sec and 50 mc/sec vertical deflection voltages for timing purposes.

C. Allow the horizontal sweep voltage to be delayed from zero to at least 0.5 microseconds with respect to the leading edge of the vertical deflection signal.

The generator is composed of three components; i.e.,

1. Main chassis comprising trigger, delay, and sweep circuitry.
2. Timing oscillator chassis containing two timing oscillators (20 and 50 mc) and amplifiers.

3. Delay line assembly consisting of approximately 300 feet of RG/11U coaxial cable.

4. Panel controls, nameplates, connectors, etc.

Generator power requirements are 115 V, 60 c/sec @ 1.5 A, ≠ 300 V d.c. @ 200 ma, -150 V d.c. @ 10 ma and ≠ 900 V d.c. @ 4 ma.

II INSTALLATION

A. Delay Line Assembly

1. Mounting. This assembly should be installed first. Looking from the rear of the oscillograph cabinet the top right side panel should be removed and the delay line assembly slid in through the resulting space. Approximately 36" from the bottom of the oscillograph cabinet four sheet metal angles will be found, mounted to the sides of the oscillograph cabinet and running its full depth. The top pair of angles will support the delay line assembly by means of the two long structural steel angles projecting from the sides of the assembly. The assembly will be offset approximately 3" to the right and should be centered in depth in the oscillograph cabinet. It is attached to the top pair of cabinet side angles by means of machine screws to be found in envelope #11 (body drill #17). Drill holes at the ends of the delay line assembly side angles through the oscillograph supporting side angles.

2. Connections. Trim one projecting end of delay cable to the proper length and connect it to the oscillograph input panel at bottom rear of the cabinet by means of the components in envelope #12. (The male connector in envelope #12 is to be used to connect the signal line from the surge generator to the oscillograph). Trim the other end of the delay cable to

the proper length and connect it to the voltage divider terminating resistor in the oscillograph in place of the original connecting cable. If after observation the terminating resistor is seen to introduce no spurious reflections, the delay line may be used for low speed as well as high speed sweeps. Its only effect then will be to introduce a 0.5 microsecond signal delay and an attenuation which can be measured.

B. Main Chassis

1. Mounting. Looking from the rear the main chassis is mounted on the right side of the oscillograph cabinet, large terminal strip down, pilot light to rear of cabinet. Chassis position should be high in the cabinet and to the rear as far as practical; when the cabinet side panel is removed the interior of the chassis should be accessible. Approximate dimensions are; top side of chassis 2" from top of cabinet, rear side of chassis 2" from rear of cabinet. A 3/4" x 1/8" structural steel angle 23-3/4" long should be fastened to the inside corner posts of the oscillograph cabinet. The main chassis can be fastened to the angle and be supported by it.

2. Panel Connections. The panel controls should be placed in the upper left section of the front panel (looking from the front) adjacent to the cathode-ray tube camera mount. A suggested arrangement is to have the auxiliary sweep speed control and the sweep delay control on a top row with the sweep speed control to the left. In the next row immediately below the top is the auxiliary timing trigger control and timing wave selector and then centered below this row is the sweep polarity selector. This arrangement should be

convenient to install and use. The specific steps to mount these controls are as follows:

1. Using nameplates, which are to be found in envelope #6, as guides, lay out mounting hole placement with adequate clearance between components both inside and outside oscillograph cabinet.

2. Sweep Speed Selector. Using the components in envelope #1 drill a 3/8" hole in the oscillograph front panel and mount the panel bushing and nameplate. Insert a 1½" length of ¼" rod in the bushing attaching the knob to the outside end and a universal joint to the other. Mount the other universal joint on the shaft of S5 on the main auxiliary sweep chassis. Connect these two universal joints together with the proper length of rod.

3. Sweep Delay Control. Using the components in envelope #2 drill a 3/8" hole in the oscillograph front panel and mount R21, the 25 kilohm resistor, and the nameplate. Looking at R21 from the front of the oscillograph run leads from the right hand terminal, center terminal, and left hand terminal to terminals 5, 4, and 3, respectively, on terminal board B on the main auxiliary sweep chassis.

4. Auxiliary Timing Trigger Control. Using the components in envelope #3 drill a 15/32" hole in the oscillograph front panel and mount the switch S2 and nameplate with the OFF position to the right. Run leads from S2 to terminals 3 and 4 on terminal board A on the main auxiliary sweep chassis.

5. Auxiliary Timing Wave Selector. Using the components in envelope #4 drill a 15/32" hole in the oscillograph front panel and mount the switch S3 and the nameplate with the OFF position of S3 in the 50 mc. position. Run leads from S3 to terminals 5 and 6 on terminal board A on the main auxiliary sweep chassis.

6. Auxiliary Sweep Trigger Selector. Using the components in envelope #5 drill a 15/32" hole in the oscillograph front panel and mount the switch S1 and the nameplate with the OFF position of S1 in the positive position. Run leads from S1 to terminals 1 and 2 on terminal board A on the main auxiliary sweep chassis.

3. Power Connections. Make the following connections between the main oscillograph power supply and the main auxiliary sweep chassis:

+ 300 V d.c. to terminal #7 on terminal board A

- 150 V d.c. to terminal #9 on terminal board A

115 V 60 cycles to terminals #13 and #14 on terminal board A

Ground to terminal #8 on terminal board A

+ 900 V d.c. to standoff on front edge of chassis

4. Signal Connections

1. Using components in envelope #7, connect lead to J1 from output end of 1.0 microsecond delay cable in the time delay circuit of the low speed sweep chassis. (Pin 7 of V1, 12AT7).
2. Using components in envelope #8, connect proper length of RG/11U coaxial cable between J2 on main auxiliary sweep chassis and sweep trigger on bottom of oscillograph rear panel. A separate trigger input jack will have to be used for the high speed sweep trigger due to the high frequencies present in the triggering waveform.

C. Oscillator Chassis

1. Mounting. Looking from the rear of the oscillograph, remove the back cover plate of the chassis upon which the front panel vertical deflection selector switch is mounted. It may be seen that the + KC terminal and - KC terminal on the rear wafer of this switch are interconnected. Remove this interconnection and run all leads to the - KC terminal, leaving the + KC terminal empty. Mount the pin jack in envelope #9 on the empty + KC terminal. This jack should face to the rear, slightly upwards, and to the right of the oscillograph cabinet. Its exact position may best be determined by placing the auxiliary oscillator chassis inside the selector switch chassis and plugging in the oscillator output pin plug into the pin jack mounted on the + KC terminal. The front face of the oscillator chassis should be flush with the rear edge of the selector switch chassis and

oscillator chassis components should adequately clear selector switch chassis components. When the optimum position is determined mount the pin jack on the + KC terminal and mount the oscillator chassis to the selector switch chassis with the screws to be found in envelope #10. (Body drill #28, tap drill #43). Jumper out the 220 ohms series resistor connecting the rear wafer of the selector switch to the cathode-ray tube vertical deflection plate lead. Cut the proper holes in the selector switch chassis back cover plate and remount on selector switch chassis. Additionally, the rear mounting braces of the switches in the selector switch chassis should be covered with insulating tape as a safety precaution.

2. Terminal Connections. Connect leads between the following oscillator chassis terminals on terminal board C and terminal board A terminals on the main auxiliary sweep chassis:

Oscillator Chassis Terminal Number	Main Auxiliary Sweep Chassis Terminal Number
1	11
2	12
3	7
4	10
5	15
6	8

3. Signal Connections. The output signals of the oscillator chassis are fed out through the output pin plug into the pin jack mounted on the + KC terminal of the front panel selector switch.

D. Necessary Changes in Oscillograph in Order to Accommodate the Auxiliary High Speed Sweep

1. Using components in envelope #13 modify the low speed sweep chassis so as to make it easily inoperable. This may be done by mounting the switch (15/32" mounting hole) in the 115 V a.c. line to all filament transformers except those supplying filament voltage to tubes #1 and #2 in the time delay circuit. Connect the pilot light (7/16" mounting hole) across one of the filament transformers whose primary voltage is to be switched. This pilot light should be mounted in an easily visible location so as to insure the low speed sweep chassis and high speed sweep chassis will not be energized simultaneously. Leave all d.c. leads connected to their original terminals. As an alternative, it may be desirable to incorporate the chassis de-energizing switches into a single DPDT switch to be mounted on the oscillograph front panel along with the pilot lights. In this case, the switch should perform the described functions in the low speed sweep chassis and switch 115 V a.c. in the auxiliary high speed sweep chassis.
2. As previously described mount new panel coaxial connectors for the trigger and vertical deflection inputs. These connectors must be used in order to obtain minimum attenuation of the high frequency components present in the anticipated waveforms.
3. As previously described, the coaxial connection from the oscillograph input panel to the voltage divider terminating resistor should be replaced with the 0.5 microsecond delay cable.

III OPERATION

In order to operate the auxiliary high speed sweep the following steps are to be taken:

1. De-energize the low speed sweep chassis.
2. Place shorting leads across high voltage terminals to ground and across sweep and intensifier coupling capacitors.
3. Disconnect low speed sweep chassis + sweep, - sweep and intensifier leads from their respective coupling capacitors.
4. From auxiliary high speed sweep chassis
   1. Connect red lead to + sweep capacitor.
   2. Connect orange lead to - sweep capacitor.
   3. Connect red and white lead to intensifier capacitor.
5. Connect high speed sweep trigger input cable to jack at bottom rear of oscillograph cabinet.
6. Remove high voltage shorting leads.
7. Energize auxiliary high speed sweep chassis by switch S4.

Auxiliary high speed sweep is now ready to operate. To observe transient waveforms:

1. Select sweep speed with sweep speed selector.
2. Adjust 0 - 1.0 microsecond signal delay with sweep delay control.
3. Auxiliary timing trigger should be in "OFF" position.
4. Auxiliary sweep trigger selector should be in the position corresponding to the sweep trigger polarity.

5. Surge push button on oscillograph front panel will initiate the desired transient.

To observe timing waves:

1. Select sweep speed with auxiliary sweep speed control.
2. Auxiliary timing trigger switch should be in "ON position.
3. Select timing wave frequency with auxiliary timing wave selector switch.
4. Place oscillograph front panel selector switch in ± KC position.
5. CRO push button on oscillograph front panel will initiate display of timing waveform.

When taking photographs of high speed transients and high frequency timing waveforms the C.R.T. intensity control should be set at maximum and the focus adjusted for optimum.

IV THEORY OF OPERATION

The electronic components of the auxiliary high speed sweep assembly are divided into three sections:

A. Timing Oscillators
B. Trigger Circuit
C. Sweep Circuit

A. Timing Oscillators

20 mc/sec Oscillator. V-12A is a conventional Hartley oscillator whose output is capacitively coupled to the buffer amplifier V-13. Fine frequency adjustment is made with slug tuned coil L-2, coarse frequency adjustment is made with the padder capacitor C-35.

50 mc/sec Oscillator. V-12B is a conventional Hartley oscillator whose output is capacitively coupled to the buffer

amplifier V-14. Fine frequency adjustment is made with slug tuned coil L-1, coarse frequency adjustment is made with padder capacitor C-19.

Relay K-3, which is controlled by panel switch S3, applies the desired timing frequency to the C.R.T. vertical deflection plate and energizes the proper buffer amplifier. The plate tuned circuit capacitance of the buffer amplifier consists entirely of the amplifier output capacitance, C.R.T. input capacitance, and distributed capacitance of the relay, selector switch, and connecting wiring. Fine tuning of the buffer amplifier tuned circuit is made by slug tuned coils L-3 or L-4. Coarse tuning is made by physically moving the leads on these coils thus removing or adding fractions of turns.

In order to display the timing wave on the screen of the C.R.T. it is necessary to introduce a pulse into the trigger circuit. This is accomplished by a connection from the pulse generator of the low speed sweep circuit through J1, K-2, and K-1 into the grid of V-3. When panel switch S-2 is placed in the "ON" position and the CRO button on the oscillograph panel is pushed, the low speed sweep chassis generates a trigger pulse which initiates the high speed sweep. In this manner, it is not necessary to generate a high voltage surge to view the timing waveforms.

B. Trigger Circuit

Limiter. V-1 acts as a limiter by virtue of its input capacitance and grid current loading. When a trigger pulse is applied capacitor C-1 and the input capacitance act as a

capacitance divider of approximately 4 to 1. If the trigger is negative, the duration of the pulse is limited to approximately 1.0 microsecond by R-2 and the effective source capacitance. If the trigger is positive, the amplitude is limited and the duration is limited to less than 0.1 microsecond by grid loading and the effective source capacitance.

Phase Inverter. V-2 is a conventional phase inverter supplying opposite polarity outputs from plate and cathode circuits. Dependent upon the input trigger polarity relay K-1, which is controlled by panel switch S-1, selects a positive pulse to be applied to the succeeding stage.

Pulse Stretcher. V-3 shapes the trigger pulse into a pulse retaining the fast initial rise but of greatly increased length so as to enable reliable operation of the following time delay stage. The stretching action is accomplished by R-13; the 2.2 meg plate load resistor of V-3. A positive grid pulse drives the grid of V-3 into the positive region where its plate resistance is low and the interstage capacitance between V-3 and V-4A, V-4B is charged rapidly through this low resistance. When the input trigger pulse is terminated V-3 is cut off, its plate resistance is very large and the interstate capacitance must discharge through the high plate load resistor R-13. C-7 and R-15 also contribute to the discharging action, the net result being a pulse with fast initial rise but increased length.

Amplifier and Integrator. V-4A is a conventional resistance-capacitance coupled amplifier with the addition of C-29 the integrating capacitor. This capacitor slows the pulse rise time down to approximately 1.5 microseconds.

Delay Stage. V-5 is a sharp cutoff tube whose bias is controlled by R-19, the chassis zero delay adjust control, and R-21, the panel delay adjust control. As the input pulse to V-5 has a sloped leading edge V-5 will have no output until the input voltage exceeds its cutoff bias. Therefore, adjustment of this bias introduces a delay of from approximately zero to 1 microsecond. As the delay introduced by V-8 varies considerably from tube to tube, R-19 has been provided as a zero adjust. With R-21 set in the minimum delay position R-19 can be adjusted until the start of the sweep and the arrival of the vertical deflection signal coincide in time.

Amplifier and Driver. V-6 and V-7 are conventional resistance-capacitance coupled amplifiers. V-6 is used to minimize inherent circuit delays and V-7 provides a low impedance driver for the final stage.

Sweep Trigger. V-8 is a hydrogen thyratron that initiates positive and negative sweeps for the cathode-ray tube. When a trigger pulse is applied to its grid through T-1, after a certain inherent delay it changes from a non-conducting to a conducting state.

Amplifier. V-4B is a conventional resistance-capacitance coupled amplifier used for phase inversion and amplification.

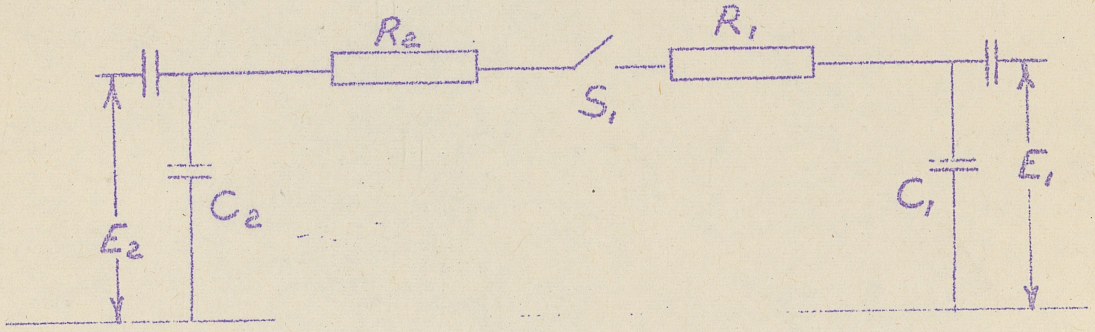
Pulse Generator. V-9 acts as a constant current generator which supplies a step function of current to the 1.1 microsecond delay line and R-39 the terminating resistor. The step of current divides equally between the delay line and R-39; the current in the delay line travels to the end of the line where it reflects from the short circuit with a phase reversal. It then travels back along the delay line and appears at R-39 once again, resulting in a voltage equal to

the voltage across R-39 but opposite in phase. The net effect is that a step function of grid voltage is transferred into a plate voltage pulse whose length is twice the length of the delay line; i.e., 2.2 microseconds.

Power Amplifier. V-10 accepts the 2.2 microsecond pulse from V-9 and transforms it into a positive going pulse of approximately 200 volts magnitude for intensification of the C.R.T. trace during the sweep.

C. Sweep Circuit

The operation of the sweep circuit may best be explained by the following diagram:



If C_1 is charged to some voltage and S_1 is then closed C_1 will discharge through R_1, S_1 and R_2 into C_2. The voltage E_1 will be a negative going exponential and voltage E_2 will be a positive going exponential. With modifications this is the basis of the high speed sweep circuit. V-8 the hydrogen thyratron replaces S_1 the switch; inductances are placed in parallel with the resistances R_1 and R_2 so as to obtain a linear rather than an exponential waveform. The sweep capacitors across which the sweep voltages are developed are C-17 and C-18; nominally they are 500 mmf mica capacitors, actually they are selected values in order to allow for distributed capacities

and the plate resistance of V-8. S-5 serves to switch values of resistance and inductance in order to obtain the different sweep times, in appearance each sweep is linear with an overshoot at beginning and end. These overshoots result in bright spots at the beginning and end of each trace of the C.R.T.; however, these spots will not fog film and all sweep times are measured between them. D.C. charging voltage is supplied by the + 900 V supply through voltage divider R-53 and R-55, current limiting resistor R-54, choke L-15, and diode V-11. L-15 serves to isolate the power supply from the sweep circuit during the sweep interval; the voltage divider R-53 and R-55 determines the length of the C.R.T. trace.

V MAINTENANCE AND ADJUSTMENTS

A. Timing Oscillators

1. Adjustments

a. Frequency. The frequency of the timing oscillators may be varied by coarse controls C-19 and C-35, and by fine controls L-1 and L-2. It is suggested that the frequency be set by means of a precision wavemeter held in the vicinity of the buffer oscillator tuned circuit. If the wavemeter is held near the oscillator tuned circuit, it can easily detune the oscillator and thus result in a false indication.

b. Magnitude. The magnitude of the timing wave is best adjusted by observing the C.R.T. timing trace and adjusting it to maximum by means of L-3 or L-4. As these inductances tune to the desired frequency with distributed capacity,

it may be possible for the tuning range not to be broad enough to allow for all possible capacity values. In this instance, it will be necessary to move the external leads on L-3 or L-4 by fractions of a turn until the tuning range is satisfactorily located.

2. Maintenance

Excluding component failure and aging, the following conditions may cause inoperation:

1. Dirty relay contacts in K-3.
2. B/ voltage below approximately 250 V.
3. Replacement of cathode-ray tube and other changes in value of distributed capacitance.

B. Trigger Circuits

1. Adjustments

The only preliminary adjustment in the trigger circuits is the zero delay adjust control R-19. With panel control R-22 on minimum delay adjust R-19 so that the desired vertical deflection waveform appears slightly to the right of the bright spot at the start of the sweep. This adjustment should not have to be made again unless V-8 is changed or its inherent delay varies considerably with time.

2. Maintenance

Excluding component failure and aging, the following conditions may cause inoperation:

1. Dirty relay contacts in K-1 or K-2.
2. B/ voltage below approximately 250 V.
3. - 150 V supply off voltage.

C. Delay Line Assembly

This assembly should require no maintenance, the only trouble arising with its use will be the same as in any coaxial cable

that is used; e.g., the values of its terminating resistors may change with time and give rise to spurious waveforms and reflections.